INSTRUCTION MANUAL — PART THREE

*for*

# MODEL LTU-2 RF TUNING UNIT

## (940 Mc-4500 Mc)

PART OF MODEL LSA
ALL BAND, DIRECT READING
SPECTRUM ANALYZER

RESTRICTED

**POLARAD ELECTRONICS CORP.**
100 METROPOLITAN AVE.
BROOKLYN 11, N. Y.
STagg 2-3464

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*May 31, 1951*

*Issue A-*

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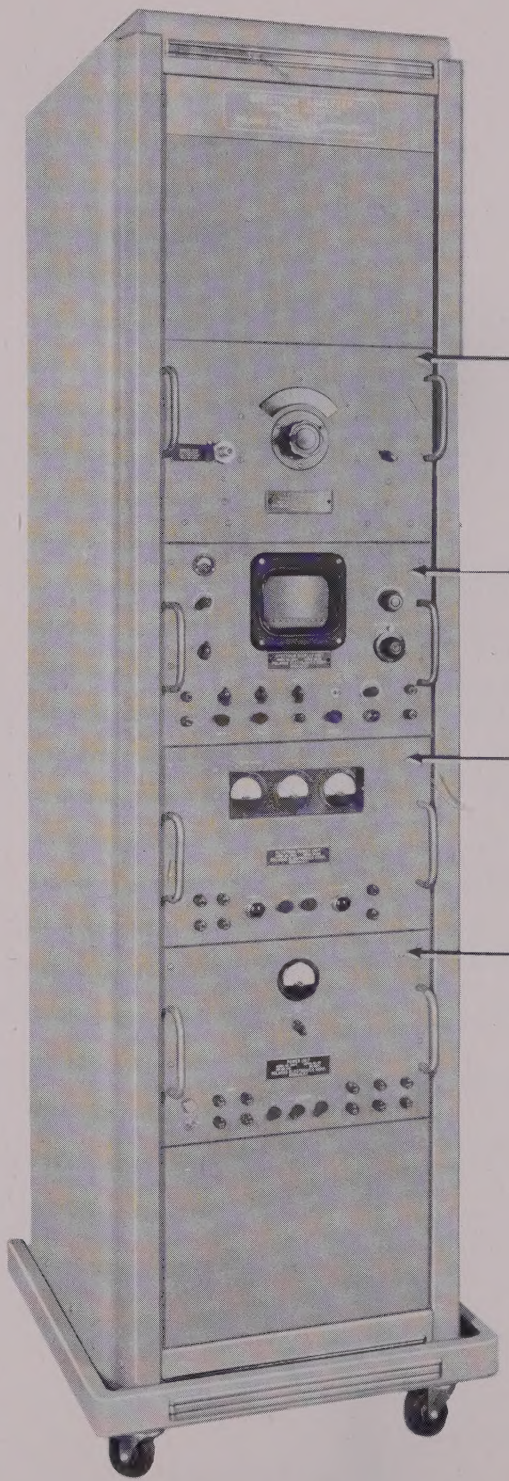



FIGURE 1. MODEL LSA SPECTRUM ANALYZER, FRONT VIEW.

# PART III

# MODEL LTU-2

# RF TUNING UNIT

# (940 Mc - 4500 Mc)

## SECTION I

## GENERAL DESCRIPTION

### 1. ORGANIZATION OF MANUAL.

a. This instruction manual describes the Model LTU-2 RF Tuning Unit, which is a part of the Model LSA All-band Direct-reading Spectrum Analyzer, designed and manufactured by the Polarad Electronics Corporation of Brooklyn, N. Y. (See fig. 1). This manual describes the electrical and mechanical features of the RF Tuning Unit covering the frequency range from 940 Mc to 4500 Mc.

b. Since the Model LSA Spectrum Analyzer consists of several major units, it has been found desirable to divide the book into four major parts, to provide the most concise organization and presentation of the material. Part I contains descriptive and maintenance data for the basic units of the Spectrum Analyzer, which consist of the Model LDU-1 Display Unit, the Model LPU-1 Power Unit, and the Model LKU-1 Klystron Power Unit. Part II of the manual provides complete operational and adjustment data for the Model LTU-1 RF Tuning Unit, covering the frequency range from 9.5 Mc to 1200 Mc. Part IV is an operating and service manual for the Model LTU-3 RF Tuning Unit, covering the frequency range from 4460 Mc to 16,520 Mc, while the present manual, Part III, is applicable to the Model LTU-2 RF Tuning Unit only.

NOTE

The restricted classification of the present manual is required because the reflex-klystron tube QK-201, which is used as the first local-oscillator, is a RESTRICTED tube. If and when the QK-201 tube is de-classified, this instruction manual and the Model LTU-2 RF Tuning Unit will be de-classified.

### 2. PURPOSE OF THE SPECTRUM ANALYZER.

a. Polarad's Model LSA Spectrum Analyzer is a laboratory instrument which is used to provide a visual indication of the frequency distribution of energy in an

rf signal in the range covered by the Tuning Unit in use. With the Model LTU-2 RF Tuning Unit connected to the basic units, radio signals in the frequency range from 940 mc to 4500 mc are converted to an intermediate frequency of 160 mc, at a power level sufficient to drive the various if circuits located within the Model LDU-1 Display Unit. Signals received and detected by this Tuning Unit are presented visually as a plot of voltage, on the vertical axis, versus frequency, on the horizontal axis, of the oscilloscope within the Display Unit. Controls are provided on the Display Unit front panel for observing on the cathode-ray tube screen a band of frequencies as narrow as 250 kc, adjustable continuously to a band as wide as 25 mc, as desired.

b. Specific applications of the Spectrum Analyzer consist of:

(1) Observing and measuring the sidebands associated with amplitude and frequency-modulated signals;

(2) Determining the presence and accurately measuring the frequency of radio and/or radar signals;

(3) Checking the spectrum of magnetron oscillators;

(4) Measuring noise spectra;

(5) Checking and observing the tracking of rf components of a radar system;

(6) Comparing two rf signals differing by a small frequency separation.

## 3. EQUIPMENT SUPPLIED.

Figure 1 shows one of the RF Tuning Units in operation with the basic units of the Spectrum Analyzer, all mounted within the deluxe steel test-rack type cabinet. Viewed from the top of the rack to the bottom, the units consist of the RF Tuning Unit, the Model LDU-1 Spectrum Display Unit, the Model LKU-1 Klystron Power Unit, and the Model LPU-1 Power Unit. The equipment supplied with the Model LTU-2 RF Tuning Unit is listed in Table 1, below:

TABLE 1. EQUIPMENT SUPPLIED.

| Polarad Model No. | Item | Description |
|---|---|---|
| LTU-2 | RF Tuning Unit (940 Mc - 4500 Mc range). | Mounted on rack panel, 12-1/2" high by 19" wide, by 21-3/4" deep. |
| | External RF Adjustable Attenuator. | Wave guide beyond cut-off attenuator; Calibrated range, 120 db; General Radio, Type 874 GA. |
| | Adaptors to type N connectors. | Used with rf attenuator. GR Type 874-Q1. |
| | 50-ohm termination. | Used with rf attenuator, GR Type 874-WM. |
| | Spanner wrench. | J. H. Williams & Co., type 482. |
| | Splinehead wrench. | #6. |
| | Allen wrench. | 1/8" across flats. |

## 4. ELECTRICAL CHARACTERISTICS, MODEL LTU-2 TUNING UNIT.

a. FREQUENCY CALIBRATION. -- The Model LTU-2 RF Tuning Unit tuning range is covered in two bands, both of which are inscribed on the calibrated tuning dial visible through the window at the top center of the front panel. The low band covers the frequency spectrum from 940 mc to 2170 mc; the high band covers the spectrum from 2040 mc to 4500 mc. The low and high band calibration marks are inscribed on the lower and upper sections of the tuning dial, respectively, as shown in figure 2.

b. OPERATING POWER REQUIREMENTS. -- Operating power for this tuning unit is supplied by two of the basic units of the Spectrum Analyzer equipment. The Model LPU-1 Power Unit supplies the 115-volt ac power for the filament transformer for the preamplifier tubes, and the positive 105-volt dc potential for the plates and screen grid circuits of the preamplifier tubes. The Model LKU-1 Klystron Power Unit supplies the 6.3 volt ac power for the heater of the reflex klystron tube, and the minus 400-volt and 1000-volt potentials for the reflector and anode electrodes, respectively, of the reflex klystron tube.

## 5. PHYSICAL FEATURES.

The Model LTU-2 RF Tuning Unit contains an external cavity klystron local-oscillator, a crystal mixer, a 160 mc preamplifier, a filament transformer (protected by 1-ampere fuses in each input line), a tracking potentiometer adjustment panel, and a mechanical drive system. The unit is tuned manually by rotating the single TUNING knob, located at the center of the front panel, which sumultaneously drives a non-contacting choke within the oscillator cavity, a tracking potentiometer for changing reflector voltage automatically, and a tuning dial which indicates frequency in megacycles on either of its two calibrated scales accurately to better than 1%. The chassis and oscillator casting are secured by means of bolts and nuts to a front panel which is painted in a gray satin finish. Two handles, located at the two sides of the front panel, are provided for ease in pulling or replacing the Tuning Unit on its draw slides in the deluxe test rack supplied. At the rear of the unit are the two operating fuses, located within the extractor type fuseholders, the two spare fuses, and the panel receptacles for connection to the basic units. Refer to section II of this manual for a chart listing all controls, with their location and functions

## 6. TECHNICAL SUMMARY, MODEL LTU-2 RF TUNING UNIT.

Frequency range:
- Low.....940 mc to 2170 mc.
- High.....2040 mc to 4500 mc.

Bandwidth.....25 mc.

Sensitivity.....Low range: -115 dbw.
High range: -105 dbw.

Tube complement.....1-QK201; 7-6AK5.

Power input:
- DC.....+ 105 v; - 300 v; - 1000 v.
- AC.....6.3 v, 2 amperes; 115 v.

Tuning dial accuracy.....Better than 1%.

Attenuation:
RF.....120 db, external, continuously variable.

IF.....60 db, in 6 db steps.

Input impedance.....50 ohms coaxial.

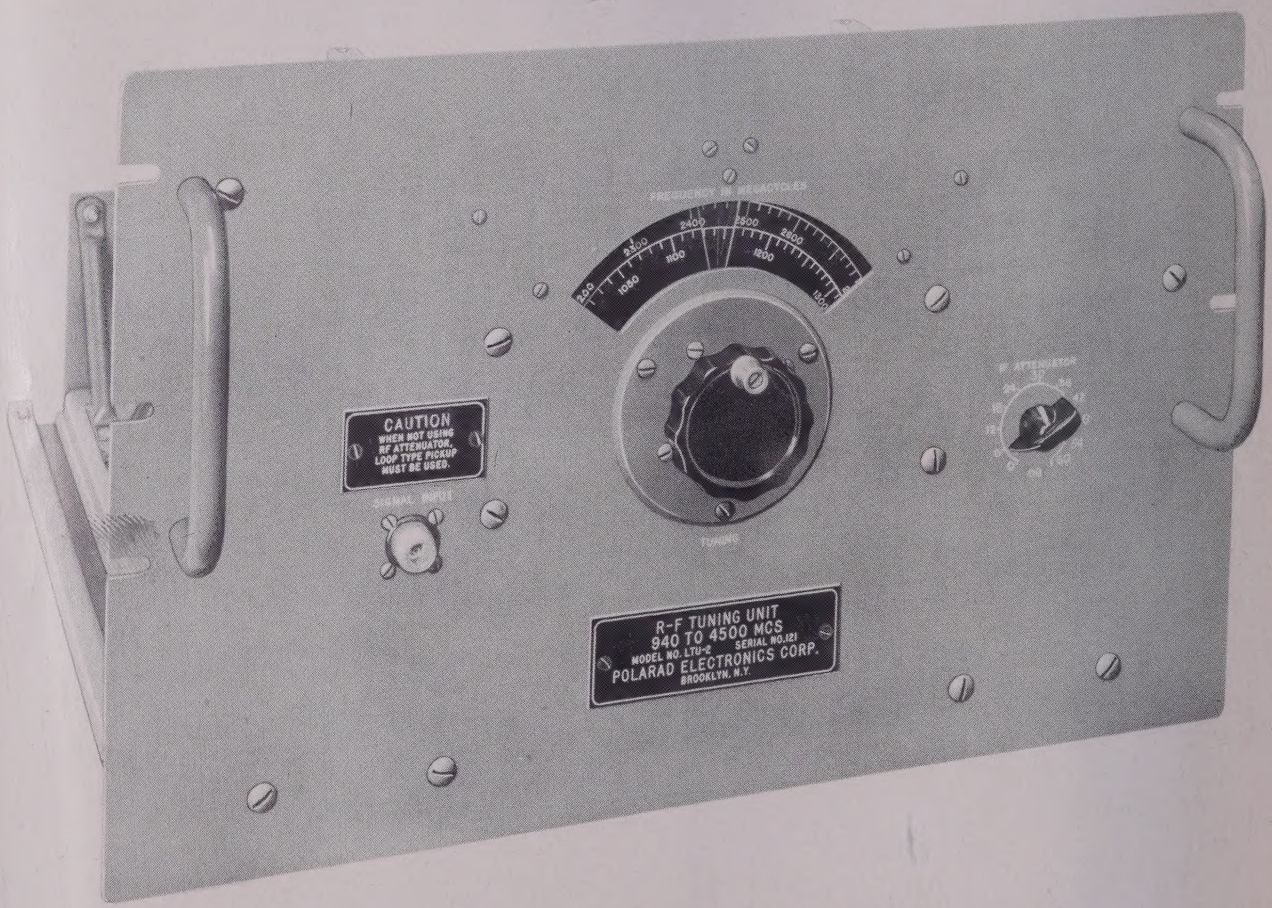



FIGURE 2. MODEL LTU-2 RF TUNING UNIT, FRONT VIEW.

## SECTION II

## OPERATING INSTRUCTIONS

### 1. INTER-UNIT CABLING CONNECTIONS. (Refer to fig. 3).

a. Connect the Model LTU-2 RF Tuning Unit to the basic units of the Spectrum Analyzer as directed below:

(1) Connect the power cable, W2, from the Power Unit TUNING HEAD connector, J2, on the equipment rear panel, to POWER receptacle J3001 on the Tuning Unit rear panel.

(2) Connect display signal cable, W5, from the Display Unit TUNING HEAD receptacle J302 to the DISPLAY receptacle J3002, on the Tuning Unit rear panel, right side.

(3) Connect klystron power cable, W4, from the Klystron Power Unit TUNING UNIT receptacle, J101, to the KLYSTRON POWER receptacle J3003, on the Tuning Unit rear panel.

(4) Connect the signal under measurement to the SIGNAL INPUT receptacle on the Tuning Unit front panel.

### 2. TABLE OF CONTROLS.

The following table lists the various operating controls located on the chassis. Location and function of each control and adjustment within the equipment is included.

TABLE 2. OPERATING CONTROLS AND ADJUSTMENTS.

| Control | Location | Function |
|---|---|---|
| TUNING | Front panel. | Tunes the unit to the desired frequency as indicated by the tuning dial. |
| IF ATTENUATOR | Front panel. | Provides 60 db of attenuation, in nominal 6 db steps. |
| INCREASE CATHODE CURRENT R3011 | Reflector control board, rear of chassis. | Changes the bias potential applied to the control grid of the reflex klystron tube V3001. |
| HIGH LIMIT control R3002 | Reflector control board, rear of chassis. | Sets maximum potential for tracking potentiometer at high end of the tuning range. |
| LOW LIMIT control R3009 | Reflector control board, rear of chassis. | Sets maximum potential for tracking potentiometer at low end of the tuning range. |

| Control | Location | Function |
|---|---|---|
| TRACK 1 control R3007 | Reflector control board, rear of chassis. | Sets proper value of tracking potentiometer at the 1060-mc calibration mark on the tuning dial. |
| TRACK 2 control R3006 | Reflector control board, rear of chassis. | Sets proper value of tracking potentiometer at the 1220-mc calibration mark on the tuning dial. |
| TRACK 3 control R3005 | Reflector control board, rear of chassis. | Sets proper value of tracking potentiometer at the 1430-mc calibration mark on the tuning dial. |
| TRACK 4 control R3004 | Reflector control board, rear of chassis. | Sets proper value of tracking potentiometer at the 1720-mc calibration mark on the low-band scale. |
| No. 4 spline-head set screw | Top surface of trapezoidal shaped plate, to the right of the oscillator cavity, as viewed from front of equipment. | Locks the oscillator push-rod adjustment screw. |
| Oscillator push-rod adjustment screw. | Accessible through aperture at right side of trapezoidal shaped plate, to the right of the oscillator cavity. | Controls the initial setting of the oscillator cavity length. |

## 3. STARTING PROCEDURE.

a. Be sure that all inter-unit cable connections are properly made. (Refer to par. 1 in this section, and to fig. 3).

b. Turn the POWER switch, located in the lower left section of the Model LPU-1 front panel, to its ON position, and allow a 10-minute warm-up period.

c. Check indications on the meters located on the Power Unit and Klystron Power Unit front panels, as described in Part I, Instruction Manual for the basic units.

d. Set controls on the Display Unit to produce a sweep base line, properly located on the screen, as described in Part I, Instruction Manual for the basic units.

e. Set the IF ATTENUATOR control to its zero setting.

## 4. OPERATING PROCEDURE.

a. To apply an rf signal to the Tuning Unit, connect the RF ATTENUATOR, supplied with the equipment, between the signal source and the SIGNAL INPUT jack, as directed in the instruction sheets attached to the rear of this manual. The external RF ATTENUATOR supplied is a General Radio, Type 874GA attenuator, with accessories.

b. No difficulty is presented in determining which of the two calibrated scales on the tuning dial is to be read in operating the equipment, since the upper-scale range is approximately twice the frequency of the lower-scale range. In operation, signals in the lower band will appear to move across the Spectrum Display screen at twice the normal rate when the tuning dial is rotated, and the high band calibrated scale is read.

## 5. OPERATING PRECAUTIONS.

a. For proper use of the Model LTU-2 RF.Tuning Unit, it is essential that true signal pips and image-frequency pips be distinguished. Apply a signal to the Tuning Unit and turn the TUNING knob until a pip appears on the screen. Then slowly tune the receiver up-scale. If the signal on the display screen moves towards the left, this is the true signal. Its frequency will then correspond to the appropriate tuning scale indication. If the signal moves towards the right, as the receiver is tuned up-scale, this is the image of the signal. The true signal will then be found 320 mc higher than the image signal on the tuning dial. Reference to the signal source will indicate approximately the range of signals applied to the Tuning Unit.

b. The CRYSTAL CURRENT meter, located on the Display Unit front panel, is used as an indicator of klystron local-oscillator functioning. Any pointer deflection is an indication of klystron output. Disregard any numerical value of the calibrated scale, since the pointer deflection varies as the oscillator is tuned over the range of the Tuning Unit. If no pointer deflection occurs at a particular frequency setting, rotate the TUNING dial throughout its range. As long as the meter pointer deflects in some frequency settings, the equipment is functioning properly. The meter is relatively insensitive, and will not indicate low current values. Trouble shooting of the equipment is required in the event that no CRYSTAL CURRENT meter indication is obtained and no signal output can be measured.

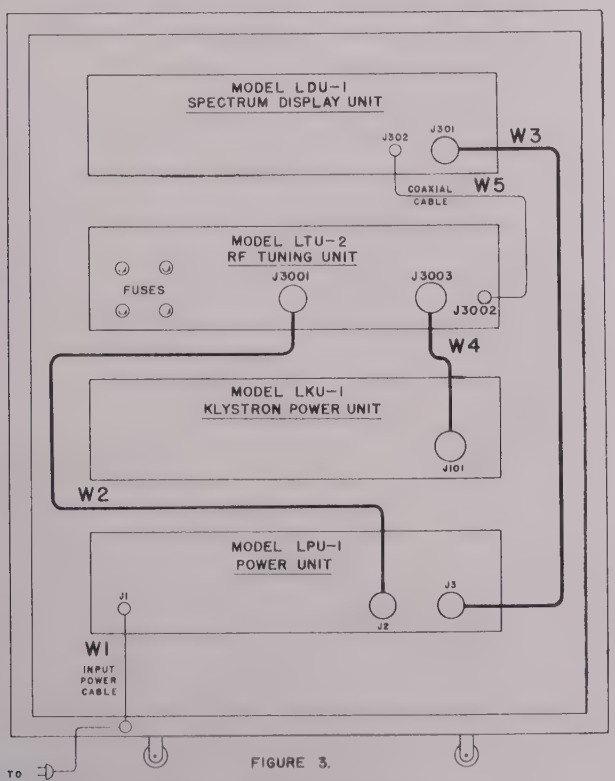



FIGURE 3.

MODEL LSA SPECTRUM ANALYZER, INTER-UNIT CABLING CONNECTIONS.

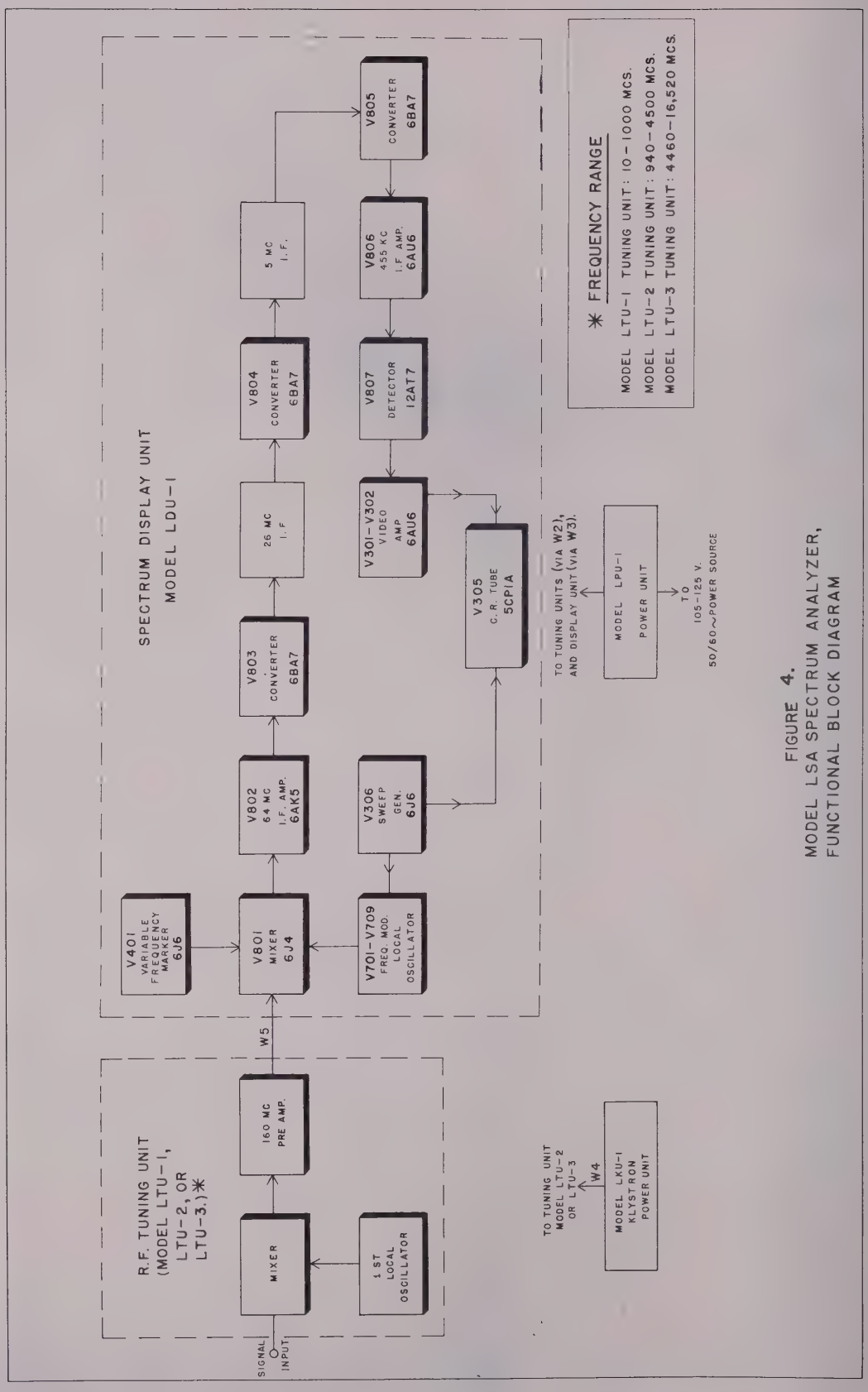



FIGURE 4.
MODEL LSA SPECTRUM ANALYZER,
FUNCTIONAL BLOCK DIAGRAM

# SECTION III

# THEORY OF OPERATION

## 1. INTRODUCTION.

The Model LTU-2 Tuning Unit is one of three tuning units supplied with the Model LSA Spectrum Analyzer. This tuning unit receives signals in the range 940 mc to 4500 mc. The range is covered in two bands, with the lower frequency range calibrated from 940 mc to 2170 mc, and the higher range calibrated from 2040 mc to 4500 mc. By means of manual tuning, signals in a 25 mc bandwidth, centered at the frequency to which the unit is tuned, are received, and converted to 160 mc (the first intermediate frequency). This 160 mc voltage is preamplified to improve signal-to-noise ratio, and is then fed by coaxial cable to the Display Unit. In the Display Unit, a second intermediate frequency of 64 mc is obtained by beating the 160 mc signal with the output of a sweeper circuit, whose center frequency is 224 mc as it sweeps over the limits from 211.5 to 236.5 Mc. Further in the Display Unit circuitry is a fixed frequency 90 mc oscillator which beats with the output of the 64 mc narrow band amplifier to produce a third beat frequency of 26 mc. Converter stages produce additional if's of 5 mc, and finally 455 kc. This 455 kc signal is detected by a 12AT7 diode tube, the output of which is amplified and applied to the vertical plates of a display tube to appear as a pip, representing the voltage of the applied signal on the vertical axis, plotted against the band of frequencies covered by the output of the sweeper circuit on the horizontal axis. The following paragraphs 2 through 5 describe the major assemblies within the tuning unit.

## 2. DETAILED FUNCTIONING, KLYSTRON OSCILLATOR.

a. A type QK-201 tube is employed as the first local-oscillator. In the lower band of operation, the signal frequency is 160 mc lower than the local-oscillator (which oscillates over the range from 1100 mc to 2330 mc.) In the higher band of operation (2040 mc to 4500 mc), the second harmonic frequency of the local-oscillator is used to heterodyne with an incoming signal. In this band, the signal frequency is 160 mc lower than the local-oscillator second harmonic frequency, which varies from 2200 mc to 4660 mc.

b. The external cavity klystron oscillator in the present equipment functions in the (1.2) mode, with a 1/4 wavelength cavity mode and a 2-3/4 reflector mode. The oscillator is tuned by changing the position of a non-contacting short-circuiting choke assembly within the cavity. (Refer to figure 5). A mechanical pulley-and-cable system, described below, is used to drive the oscillator choke assembly (mounted at the end of the push-rod adjustment screw) as the TUNING dial is rotated. The voltage applied to the reflector electrode of the klystron tube is simultaneously tracked with the TUNING dial rotation by means of a tracking potentiometer, having four equally spaced taps. The voltage at each tap is maintained at proper level by a voltage-divider network, consisting of four potentiometers designated TRACK 1, TRACK 2, TRACK 3, and TRACK 4.

Figure 5. Cross Section - Non-contacting Short.

c. MECHANICAL DRIVE SYSTEM. -- The drive system used in tuning the klystron-oscillator consists of a pair of pulley shafts, two lines of stainless steel cable, one push-plate, two hollow guide-rods, and one bearing block. When the TUNING knob is rotated, the drive-pulley shaft winds or unwinds (depending on the direction of rotation) the drive cable. This cable is connected to the first hollow guide-rod by means of a locking-nut and collet. The cable transmits TUNING knob motion through the guide-rod to the push-plate, which activates the choke-assembly push-rods of the oscillator. To prevent the push-plate from moving in a distorted path, a second guide-rod is attached to the plate. Both guide-rods are directed in their motion by the bearing block, which is rigidly mounted to the main casting. The drive cable continues beyond its fastening through the hollow guide-rod and push-plate to a counter shaft, located at the right end of the casting (as viewed from the front of the equipment). A second line of stainless steel cable connects the two shafts in such a manner that when one cable winds, the other unwinds. This arrangement is required to obtain a positive driving action. A spring and turnbuckle in the second cable is used as an anti-backlash device. The push-plate, of trapezoidal shape (located to the right of the external oscillator-cavity), is linked directly to the non-contacting choke assembly, shown in cross-sectional view in figure 5. This linkage consists of two choke assembly push-rods, shown in figure 6. At their right ends, the push rods are terminated in a metal yoke and stud, which are spring-loaded to a setscrew located within a threaded hole in the trapezoidal push-plate.

## 3. DETAILED FUNCTIONING, CRYSTAL MIXER.

a. A type 1N21B silicon diode is employed as the crystal mixer, which develops a beat signal of 160 mc when the fundamental frequency of the klystron oscillator and the applied signal in the low band range of the tuning unit are coupled to its input. For example, when an rf signal of 940 mc is applied through the SIGNAL INPUT jack to the crystal mixer, the klystron oscillator is tuned to produce an output voltage of 1100 mc. The resultant difference frequency of 160 mc at the output of the crystal mixer is coupled, by coaxial cable, to the input stage of a stagger-tuned if pre-amplifier. The 160 mc voltage is amplified in this circuit to a level suitable for the mixing and amplifying functions performed by the IF circuits in the Model LDU-1 Display Unit.

b. In operating the Tuning Unit over its high-band range, the second harmonic of the klystron oscillator frequency is used to beat with the incoming rf signal. This second harmonic component is actually developed in the crystal mixer, due to the mixer's non-linear characteristics. For example, when the Tuning Unit is tuned to a signal frequency of 2040 mc, the fundamental local oscillator frequency is 1100 mc. The second harmonic of the oscillator frequency is then 2200 mc. This second harmonic component beats with an incoming 2040 mc signal to produce a difference frequency of 160 mc, which is fed to the preamplifier.

## 4. DETAILED FUNCTIONING, PREAMPLIFIER.

The if preamplifier receives signals from the crystal mixer at a frequency of 160 mc, and amplifies them to such a level that they may be transmitted through a coaxial cable to the Spectrum Display Unit without introducing additional noise. The preamplifier amplifies signals in a band 28 mc wide, centered at 160 mc. It contains seven type JAN-6AK5 tubes. The first tube V1301 acts as an impedance transformer, matching the input of the preamplifier to the output of the crystal mixer. Tubes V1302 through V1304 comprise a stagger-tuned triplet, while tubes V1305 through V1307 make up the second triplet. The first stage in each triplet is tuned to the center of the pass-band at 160 mc, the second stage is tuned to 175 mc, and the final stage is tuned to 146 mc. The IF ATTENUATOR varies the cathode impedance of the first triplet. Ten 6 db steps of if attenuation, ranging from 0 to 60 DB, are provided to control the sensitivity of the receiver.

## 5. POWER SUPPLY CIRCUIT.

a. Operating power for the Tuning Unit is obtained from the Power Unit and Klystron Power Unit by inter-unit cabling connections. The Klystron Power Unit supplies all necessary voltages for the klystron tube operation. The Power Unit supplies the positive 105-volt potential for the plate and screen girds of the JAN-6AK5 amplifiers, in addition to 115-volt ac power for the filament transformer, and passes 115-v ac on to power the Klystron Power Unit, Model LKU-1.

b. The filament transformer T3001, is mounted on the chassis main frame, to the right and rear of the reflector adjustment control panel. The 6.3-volt ac output from the transformer is used as heater power for the preamplifier, and for pilot lamps E3001 and E3002, which illuminate the tuning dial when power is applied.

NOTES

1. An I-F Attenuation table is provided with each Model LTU-2 RF Tuning Unit supplied.

2. A Tuning Dial Calibration Chart is provided with each Model LTU-2 RF Tuning Unit supplied.

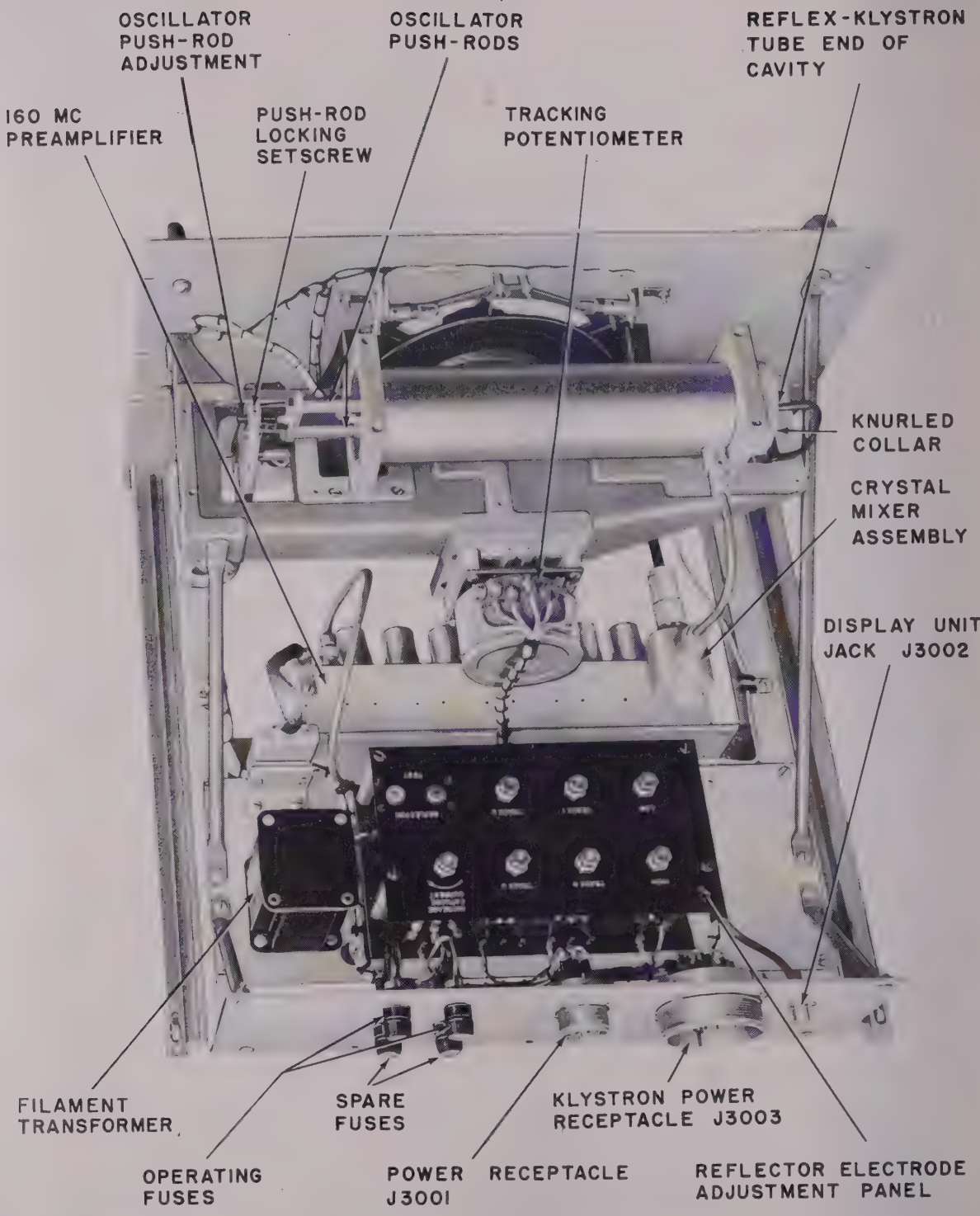



FIGURE 6. MODEL LTU-2 RF TUNING UNIT, TOP VIEW.

## SECTION IV

## MAINTENANCE

### 1. GENERAL.

a. This section covers corrective maintenance for the Model LTU-2 RF Tuning Unit. Included are instructions for replacing the klystron oscillator tube and the alignment procedure required after installing a new klystron tube.

b. The material contained in this section is to be used in conjunction with the schematic circuit diagram appearing at the rear of this manual. Specific reference to this diagram is made throughout the text, where applicable.

### 2. PRE-OPERATIONAL CHECKS AND ADJUSTMENTS.
(Refer to figure 6.)

a. The Instruction Manual, Part I, for the Model LSA Spectrum Analyzer gives complete pre-operational checks and adjustment procedures for the basic units. The following directions apply to the Model LTU-2 (940-4500 mc) Tuning Unit only, and should be performed after all checks and adjustments to the basic units are completed:

(1) Examine all tubes in the 160 mc preamplifier to see that they are firmly seated in their tube sockets.

(2) Check that switch action of the IF ATTENUATOR S3001 is firm and positive for each of its 11 positions. Set the IF ATTENUATOR to its 0 DB position, after performing the check.

(3) Check that rotation of TUNING knob throughout its range in both clockwise and counterclockwise rotation is smooth and continuous; the knob must be tight on its shaft.

(4) Examine all plugs and connectors to see that they are firmly seated and screwed tight.

(5) With operating power OFF, check that the klystron tube shield, forming the top of the oscillator casting, is firmly in place.

> **WARNING**
>
> Application of power to this Tuning Unit results in very high voltages which are dangerous to life. Personnel must observe all safety precautions at all times. Do not attempt to remove the klystron tube from its cavity when operating power is applied.

(6) After connecting all cables to the tuning unit, throw the POWER switch on the Model LPU-1 Power Unit of the Spectrum Analyzer to its ON position. The tuning dial will become illuminated. Energizing of the tuning dial lamps indicates that 115-volt ac power is applied to the Tuning Unit, and that the filament transformer is developing 6.3-volt output.

## 3. REPLACEMENT OF OSCILLATOR TUBE.

(Refer to figure 6.)

a. A type QK-201 tube is used as the reflex klystron oscillator in this Tuning Unit. The klystron tube is partially seated within the left end of the oscillator cavity, which is assembled on the casting directly to the rear of the equipment front panel. If replacement of the oscillator tube is necessary, proceed as follows:

(1) BE SURE TO TURN OPERATING POWER OFF. Throw the POWER switch on the Model LPU-1 Power Unit to the OFF position. In addition, remove Klystron Power Unit cable W4 from KLYSTRON POWER receptacle J3003 at the Tuning Unit rear panel. Also remove Power Unit cable W2 from POWER receptacle J3001 at the Tuning Unit rear panel.

(2) Remove the five No. 6-32 binding head screws which secure the protective shield to the oscillator casting. Three of the screws are located at the top of the casting, close to the equipment front panel; the other two screws are at the top rear edge of the casting. After removing the screws, lift the shield from the casting, so that the tube socket assembly and oscillator cavity are accessible.

(3) Remove the two screws which hold the bakelite protective cap to the left end of the cavity.

(4) Gently pull the reflector lead, which passes through the center of the protective cap, out of its banana jack contact on the klystron tube. Remove the protective cap from the reflector lead.

(5) Use the spanner wrench supplied with the equipment to loosen the knurled collar at the end of the cavity. DO NOT REMOVE THE COLLAR COMPLETELY.

(6) Grasp the projecting end of the klystron tube, gently rotating it in a clockwise direction while simultaneously withdrawing the tube from its spring holders within the cavity.

> NOTE
>
> If the klystron tube cap cannot be adequately grasped, it may be necessary to remove the large knurled collar at the rear end of the cavity. In removing the collar, a spring and retaining ring within the cavity may also come out. In this event, re-insert the spring into the cavity, then follow with the retaining ring, and replace the collar by re-threading it on to the cavity with a half-turn.

(7) With the klystron tube and socket now outside of the cavity, withdraw the tube from the socket assembly.

b. Place a new QK-201 tube in the socket assembly. Use care to avoid breaking or bending the tube pins. With the left hand holding the cap of the klystron tube, use the right hand to guide the socket assembly into the center of the cavity, by gently pulling on the socket assembly leads.

(1) Insert the tube carefully within the center of the cavity, and press it all the way in against a noticeable resistance as the internal contact ring-fingers make engagement, until it meets a positive stop.

(2) Then re-tighten the large knurled collar, using the spanner wrench.

(3) Connect the miniature banana jack contact to the indentation on the reflector cap of the klystron tube.

(4) Attach the bakelite protective cap to the cavity by means of the two thumbscrews.

(5) Replace the protective shield over the top of the oscillator casting, using the five No. 6-32 binding head screws to secure the shield to the assembly.

(6) Reconnect Power Unit cable W2 and the Klystron Power Unit cable W4 to the appropriate receptacles on the equipment rear panel. Throw the POWER switch on the Model LPU-1 Power Unit to its ON position. Allow a ten-minute warm-up period. Then re-align the tuning unit, as directed below.

## 4. ALIGNMENT PROCEDURE.

The following table gives the alignment procedure, which is required after replacing a klystron local-oscillator tube in the Model LTU-2 RF Tuning Unit.

TABLE 3. Model LTU-2 TUNING UNIT ALIGNMENT PROCEDURE

| Step | Adjustment | Adjustment Location | Proper Indication |
|---|---|---|---|
| 1 | Set POWER switch to OFF Position. | Front panel of Power Unit. | All pilots and tuning dial lights out. |
| 2 | Rotate the INCREASE CATHODE CURRENT screwdrive control to extreme counter-clockwise position. | Reflector control board, at rear of Tuning Unit. | None. |
| 3 | Set POWER switch to ON position, and wait approximately 1-minute for delay-relay in Klystron Power Unit to complete its cycle. | Front panel of Power Unit. | a. All pilots light.<br>b. Meter pointer on Power Unit panel deflects to an on-scale indication, depending on position of METER SELECTOR.<br>c. After the one-minute delay period, pointers of the three meters on the Klystron Power Unit panel deflect as given below:<br>CATHODE CURRENT<br>On scale.<br>REFLECTOR VOLTAGE<br>600.<br>ANODE VOLTAGE: 400. |
| 4 | Rotate the INCREASE CATHODE CURRENT control Clockwise until pointer of CATHODE CURRENT meter indicates 45 ma. (Re-check and readjust, if necessary, after a 10-minute operating period.) | Reflector control board, at rear of Tuning Unit. | CATHODE CURRENT meter pointer remains at 45 ma. calibration mark.<br>Pointer of CRYSTAL CURRENT meter on Spectrum Display Unit deflects to the right. |

NOTE

A pointer deflection on the CRYSTAL CURRENT meter is an indication only that the klystron oscillator is functioning. Trouble-shooting of the equipment is required when no CRYSTAL CURRENT meter indication is obtained and no IF output is observed.

TABLE 3. Model LTU-2 TUNING UNIT ALIGNMENT PROCEDURE
(continued)

| Step | Adjustment | Adjustment Location | Proper Indication |
|---|---|---|---|
| 5 | Rotate the TUNING knob to the high-frequency end of the tuning dial. | Top center of Tuning Unit front panel. | 2170 Mcs calibration mark, on the lower scale appears under the index hairline. |
| 6 | Connect the r-f output of a signal source, producing an un-modulated 2170-Mcs signal, into SIGNAL INPUT jack. | Left center section of Tuning Unit front panel. | A pip, corresponding in frequency to the r-f signal applied to the INPUT jack, appears on the screen of the Model LDU-1 Display Unit.<br><br>If no pip is observed after performing step or if the pip is not centered on the screen, proceed as directed in steps 7 through 11. If the pip is centered on screen, skip to step 12. |
| 7 | Loosen the no. 4 spline-head set screw, which functions as a lock for the oscillator push-rod adjustment screw. | Top surface of trapezoidal-shaped plate, to the right of oscillator cavity. | None. |
| 8 | Slowly rotate the oscillator push-rod adjustment screw by means of a no. 1/4-28 Allen wrench first in one direction, then in the other direction, until the signal pip is centered on the screen of the Display Unit. | Aperture at right side of trapezoidal-shaped plate, to the right of oscillator cavity. | R-f signal pip moves across spectrum display. |
| 9 | Rotate the HIGH limit screwdriver control until maximum pointer deflection on the CRYSTAL CURRENT meter is obtained. | Reflector control board, rear of Tuning Unit. | CRYSTAL CURRENT meter, on Display Unit front panel, shows increased reading. |
| 10 | If step 9 causes the signal pip to shift from the center of the screen, re-trim the oscillator push-rod adjustment screw until the pip is re-centered. Then re-trim the setting of HIGH limit control until maximum swing of CRYSTAL CURRENT meter pointer is obtained. | a. Projecting Allen head screw at trapezoidal-plate aperture.<br><br>b. Reflector control board, rear of Tuning Unit. | a. R-f signal pip moves across the display.<br><br>b. Increased reading on CRYSTAL CURRENT meter. |

TABLE 3. Model LTU-2 TUNING UNIT ALIGNMENT PROCEDURE
(continued)

| Step | Adjustment | Adjustment Location | Proper Indication |
|---|---|---|---|
| 11 | After performing steps 8 and 9 as often as necessary until maximum CRYSTAL CURRENT meter indication occurs at the same time that the pip is centered on the screen, tighten the no. 4 spline-head set screw, which locks the oscillator push-rod adjustment screw. | Top surface of plate, to the right of the oscillator cavity. | Signal pip remains at the center of the display. |
| 12 | Rotate the TUNING knob to the low-frequency end of the tuning dial. | Center of Tuning Unit front panel. | 940 Mcs calibration mark, on the lower dial, appears under the index hairline. |
| 13 | Slowly rotate the LOW limit screwdriver control in a counterclockwise direction and observe the CRYSTAL CURRENT meter for an abrupt change (either an increase or decrease) in reading. | Reflector control board, rear of Tuning Unit. | Abrupt change in pointer deflection on CRYSTAL CURRENT meter. |
| 14 | Mark an index line (using a colored pencil or similar device), on the panel of the reflector control board, showing the orientation of the slot on the LOW control for step 13. | ..... | Index mark on the panel lines up with position of LOW screwdriver slot. |
| 15 | Slowly rotate the LOW limit screwdriver control in a clockwise direction, and observe the CRYSTAL CURRENT meter for a second abrupt change in reading. | Reflector control board. | Second abrupt change in pointer deflection on CRYSTAL CURRENT meter. |
| 16 | Mark an index line on the panel of the reflector control board, showing | ..... | Index mark on the panel lines up with second position of LOW screwdriver slot. |

TABLE 3. Model LTU-2 TUNING UNIT ALIGNMENT PROCEDURE
(continued)

| Step | Adjustment | Adjustment Location | Proper Indication |
|---|---|---|---|
| | the orientation of the slot on the LOW control for step 15. | | |
| 17 | Rotate the LOW limit screwdriver control so that the slot at the top of its shaft is oriented midway between the two index marks inscribed after steps 13 and 15. | Reflector control board. | None. |
| 18 | Rotate the TUNING knob until the lower scale 1060-Mc calibration appears under the index hairline, and rotate the TRACK 1 screwdrive control shaft for maximum pointer deflection on CRYSTAL CURRENT meter. | Center of Tuning Unit front panel, and reflector control board. | 1060 Mcs mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter. |
| 19 | Rotate the TUNING knob until the lower dial 1220-Mcs mark appears under the index hairline, and rotate the TRACK 2 screwdriver control shaft for maximum pointer deflection on CRYSTAL CURRENT meter. | Center of Tuning Unit front panel, and reflector control board. | 1220 Mcs mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter. |
| 20 | Rotate the tuning knob until the lower dial 1430-Mcs mark appears under the index hairline, and rotate the TRACK 3 screwdriver control shaft for maximum pointer deflection on CRYSTAL CURRENT meter. | Center of Tuning Unit front panel, and reflector control board. | 1430 Mcs mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter. |
| 21 | Rotate the TUNING knob until the lower dial 1720-Mcs mark appears under the index hairline, | Center of Tuning Unit front panel, and reflector control board. | 1720 Mcs mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter. |

TABLE 3. Model LTU-2 TUNING UNIT ALIGNMENT PROCEDURE
(continued)

| Step | Adjustment | Adjustment Location | Proper Indication |
|---|---|---|---|
| | and rotate the TRACK 4 screwdriver control shaft for maximum pointer deflection on CRYSTAL CURRENT meter. | | |
| 22 | Tune the unit to 2170 Mcs, and readjust the HIGH limit screwdriver control shaft for maximum pointer deflection on CRYSTAL CURRENT meter. | Reflector control board. | 2170 Mcs, mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter. |
| 23 | Re-check steps 12 through 22 and readjust if subsequent tracking control settings have disturbed maximum CRYSTAL CURRENT indications of earlier adjustments. | Reflector control board. | See steps 12 through 22 above. |

## 5. PREAMPLIFIER ALIGNMENT.

a. The preamplifier of the Model LTU-2 Tuning Unit is located beneath the oscillator cavity, and is positioned with the tubes in a horizontal plane for ease of accessibility. The preamplifier sub-chassis is supported by a metal flat plate, which is secured to an aluminum angle extending across the side legs of the main frame, by means of mounting screws. To remove the preamplifier sub-chassis for alignment, unscrew the four mounting screws (two at each side) which hold the mounting feet of the sub-chassis to the metal angle and plate. Disconnect the RG-71/U cable termination, P3007, from the XTAL MIXER INPUT receptable J3007, on the top left side of the sub-chassis. Do not remove the other cable connections. Proceed as directed below:

(1) Use a signal generator within the frequency range from 146 Mcs to 175 Mcs as the signal source.

(2) Connect the output cable of the signal generator through a suitable pad (providing at least 6 db attenuation) directly into the XTAL MIXER INPUT jack J3008, located at the top left side of the preamplifier.

(3) Be sure that the multi-conductor cable terminating in plug P3007 is making good electrical contact with the vertically mounted receptacle J3007, located below and to the right of the oscillator casting. Also check that inter-unit cable W5 connects the signal output at DISPLAY UNIT jack J3002, on the rear panel, to TUNING HEAD jack J302, on the Spectrum Display Unit. With the cables connected as directed, align the preamplifier by observing the signal pip on the screen of the Display Unit.

(4) If desired, an r-f voltmeter may be used as the indicating device in this alignment procedure, instead of utilizing the spectrum display. In this case, disconnect cable W5 from the DISPLAY UNIT jack J3002. Connect the r-f voltmeter to J3002 through a 50-ohm terminated cable.

NOTE

If an r-f voltmeter is used at the output of the preamplifier, vary the signal generator output lever control so that a voltmeter indication no greater than 0.4 volt is obtained throughout the alignment procedure.

b. STEP-BY-STEP PROCEDURE: -- Allow the signal generator and the preamplifier a 10-minute warm-up period; then follow the steps outlined immediately below:

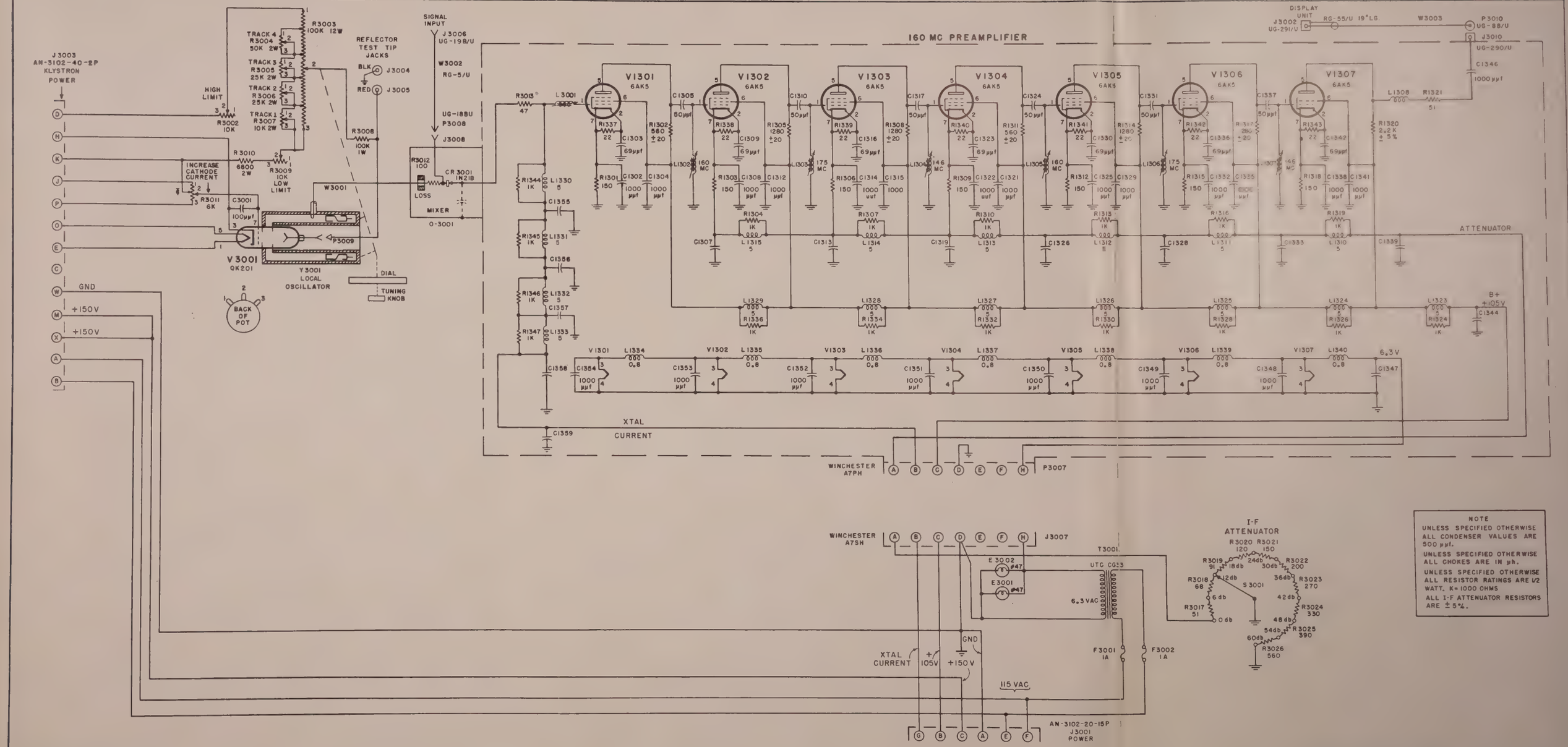
(1) Set the controls on the signal generator to produce a cw signal of 146 Mcs, and tune the two adjustment screws marked 146 Mc (L1304 and L1307) until maximum output is obtained on the spectrum display screen, or on the r-f voltmeter.

(2) Set the controls on the signal generator to produce a cw output frequency of 175 Mcs, and tune the two adjustment screws marked 175 Mc (for L1303 and L1306) until maximum output is obtained.

(3) Set the controls on the signal generator to produce a cw output frequency of 160 Mcs, and tune two of the three adjustment screws marked 160 Mc (for L1302 and L1305) until maximum output is obtained. The adjustment screw for L4001, located to the left of the first amplifier tube V1301, as viewed from the top of the sub-chassis, is adjusted as directed in step (5) below.

(4) After completing steps (1) through (3) above, the preamplifier preliminary alignment is completed. For optimum adjustment, however, its response should be checked. Construct a response curve, by varying the output of the signal generator over the range from 146 to 175 Mc, noting the output voltage at several frequencies. If necessary, slightly re-tune the 160 Mcs inductors L1302 and L1305. At the 3 db points, the bandwidth of the preamplifier is approximately 28 Mc, with a voltage gain of approximately 10 (20 db), for an input signal of 0.02 volt.

(5) To tune input inductor L3001, in the grid circuit of the first amplifier tube V1301, disconnect the signal generator output cable from XTAL MIXER INPUT jack J3008 and re-connect coaxial cable W3002 from the crystal mixer assembly 0-3001 to the XTAL MIXER INPUT jack. Apply a test signal to the Tuning Unit through the external RF attenuator if the signal power level is greater than 1 milliwatt, and rotate the TUNING dial to the same frequency as the signal source. Rock the TUNING dial until the pip representing the detected test signal appears at the center of the Spectrum Display Unit screen. Tune the variable input inductor L3001 critically by rocking its adjustment screw until the maximum height of the signal on the screen is obtained.

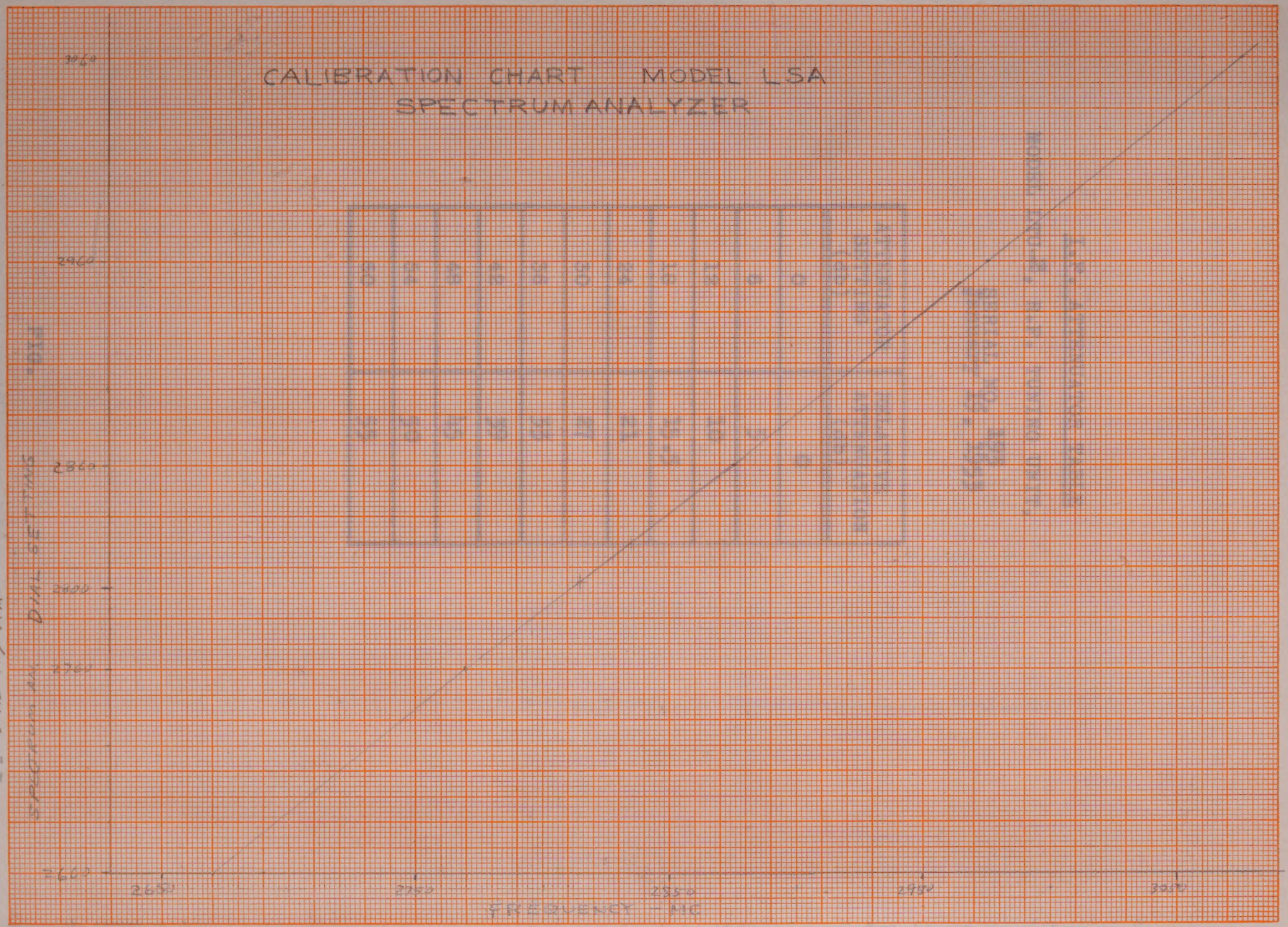


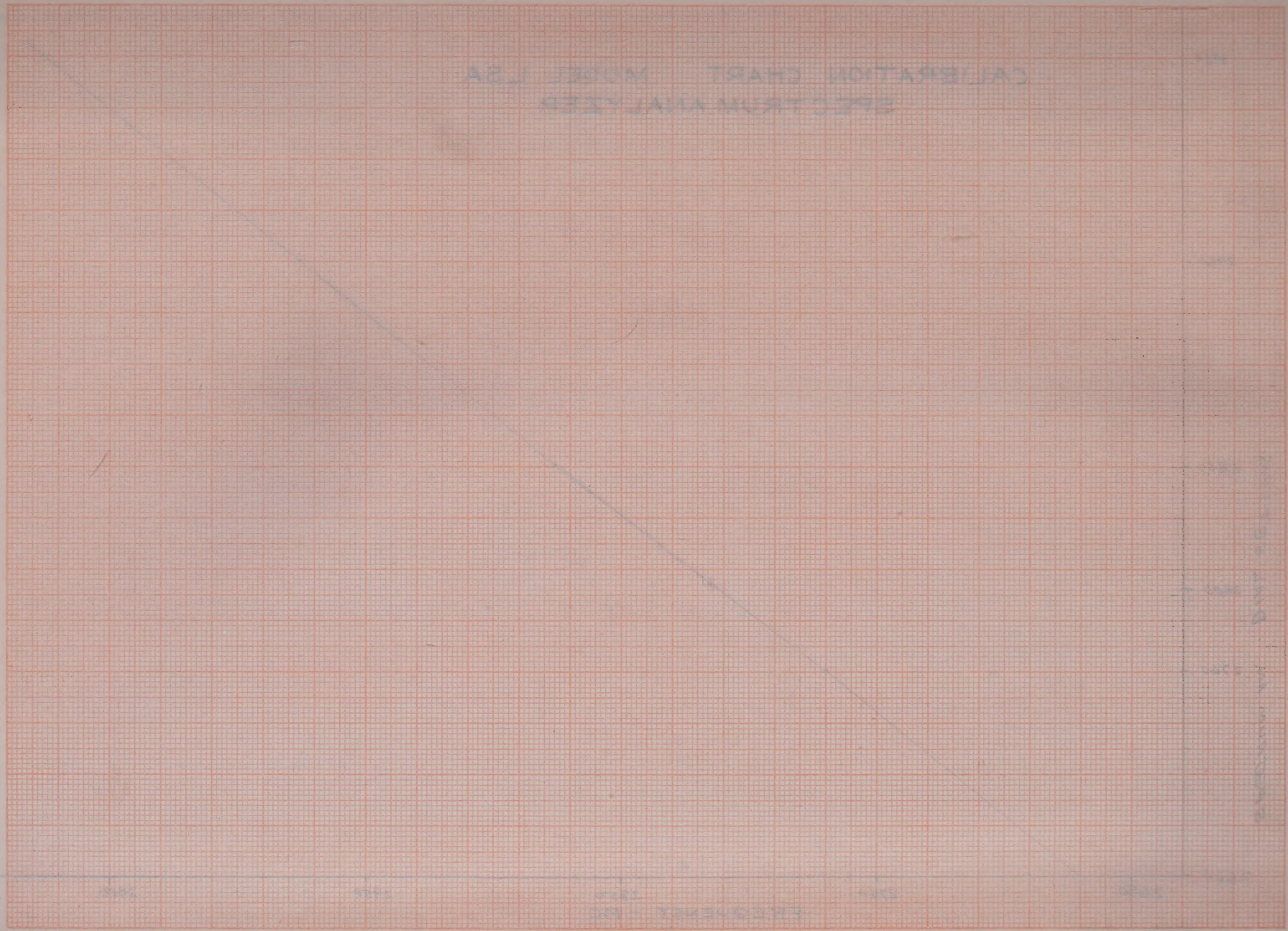

POLARAD ELECTRONICS CORP.

TUNING UNIT (PART OF SPECTRUM ANALYZER) SCHEMATIC DIAGRAM 940-4500 MC, MODEL LTU-2.

FIGURE 7

359-14 KEUFFEL & ESSER CO.
Millimeters, 5 mm. lines accented, cm. lines heavy.
MADE IN U.S.A.





## I.F. ATTENUATOR TABLE

MODEL LTU-2, R.F. TUNING UNIT,

SERIAL NO. 193
January 19, 1953

| ATTENUATOR SETTING (db) | RELATIVE ATTENUATION (db) |
|---|---|
| 0 | 0 |
| 6 | 5 |
| 12 | 10 |
| 18 | 15.5 |
| 24 | 21 |
| 30 | 27 |
| 36 | 33 |
| 42 | 39 |
| 48 | 45 |
| 54 | 50 |
| 60 | 55 |

FIG.